

WHAT IS CLAIMED IS:

1. A cooling apparatus for cooling an optical element provided in a vacuum atmosphere, said cooling
5 apparatus comprising:

a radiational cooling part, arranged apart from the optical element, for cooling the optical element by radiation heat transfer; and

a controller for controlling temperature of
10 the radiational cooling part.

2. A cooling apparatus according to claim 1,
further comprising a sensor for detecting temperature

of the optical element, wherein said controller
15 controls said radiational cooling part so that the
temperature detected by said sensor may be a
predetermined value.

3. A cooling apparatus according to claim 1,
20 wherein said controller includes a coolant feed part,
formed in said radiational cooling part, for flowing
coolant along a channel for coolant to flow through.

4. A cooling apparatus according to claim 3,
25 wherein the temperature of the coolant is set to be
substantially constant.

5. A cooling apparatus according to claim 3,
wherein said controller controls temperature of the
radiational cooling part so that temperature of the
optical element may be a predetermined value and
5 temperature of the coolant is substantially the same as
the predetermined value.

6. A cooling apparatus according to claim 1,
further comprising a radiation shielding member that
10 prevents said radiational cooling part from absorbing
the heat from a member other than the optical element.

7. A cooling apparatus according to claim 1,
wherein said radiational cooling part includes:
15 a cold plate forms a temperature difference
from the optical element;
a Peltier element, controlled by said
controller and coupled with the cold plate, for cooling
the cold plate using a Peltier effect; and
20 a radiator block that includes a channel for
coolant to flow through, and draws heat from said
Peltier element,
wherein said controller has a coolant feed
part for flowing the coolant along the channel.

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8. A cooling apparatus according to claim 7,
wherein temperature of the coolant is set to be
substantially constant.

5 9. A cooling apparatus according to claim 7,
wherein said controller controls temperature of said
radiational cooling part so that temperature of the
optical element may be a predetermined value, and
temperature of the coolant is substantially the same as
10 the predetermined value.

10. A cooling apparatus according to claim 7,
further comprising a radiation shielding member that
prevents said radiational cooling part from absorbing
15 the heat from a member other than the optical element.

11. A cooling apparatus according to claim 10,
wherein said optical element is a mirror, wherein said
radiational cooling part is provided on a rear surface
20 side of the mirror.

12. A cooling apparatus according to claim 7,
wherein said coolant feed part flows the coolant along
the channel.
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13. A cooling apparatus according to claim 1,
wherein the optical element is a mirror.

14. A method for cooling an optical element located in a vacuum atmosphere, said method comprising the steps of:

sensing temperature of the optical element;

5 and

cooling a plate so that the temperature of the optical element detected by said sensing step may become a predetermined value, the plate being arranged apart from the optical element and absorbing heat from
10 the optical element.

15. A method according to claim 14, wherein the cooling step flows coolant having substantially

constant temperature to a channel formed in a radiator
15 block provided at a heat exhaust side of a Peltier element connected to the plate.

16. A method according to claim 14, wherein the cooling step flows coolant having temperature that is
20 substantially the same as a predetermined value to a channel formed in a radiator block provided at a heat exhaust side of a Peltier element connected to the plate.

25 17. An exposure apparatus that exposes an object using a pattern on a reticle or mask, said exposure apparatus comprising:

a cooling apparatus; and
an optical system that includes at least one
optical element disposed in a vacuum atmosphere,
wherein said cooling apparatus includes:
5 a radiational cooling part, arranged apart
from the at least optical element, for cooling the
optical element by radiation heat transfer; and
a controller for controlling temperature of
the radiation cooling part.

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18. An exposure apparatus according to claim 17,
wherein the optical element included in the optical
system is a mirror arranged in an optical path from the
reticle or the mask to the object.

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19. An exposure apparatus according to claim 17,
wherein light that passes from the reticle or the mask
to the object through the optical system has a
wavelength of 10 nm to 15 nm.

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20. A device fabrication method comprising the
step of:

exposing an object using an exposure
apparatus; and

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performing a development process for the
object exposed,

wherein an exposure apparatus includes:

a cooling apparatus; and
an optical system that includes an optical
element cooled by said cooling apparatus, and exposes a
pattern formed on a reticle or mask onto an object,
5 wherein said cooling apparatus includes:
 a radiational cooling part, arranged apart
from the optical element, for cooling the optical
element by radiation heat transfer; and
 a controller for controlling temperature of
10 the radiation cooling part.
